



Materials Engineering Branch

TIP*



No. 083 Low Temperature Limits for O-ring Materials

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The most commonly used O-ring materials for space flight are fluorocarbon rubber (Viton), silicone and fluorosilicone rubbers. As all three have different physical and chemical properties as well as usable temperature range, it is important to know some of the major differences to allow for the proper selection for the application.

Viton rubber has excellent mechanical properties such as tensile strength, elongation, and tear-resistance. It is unaffected by many common solvents and chemicals. It has a useable temperature range of -25°C to $+200^{\circ}\text{C}$ and it has low vacuum outgassing usually requiring no bake out. There have been cases in recent years where additives (usually plasticizer) have been used in the formulation of Viton. In such cases, it has been necessary either to wash the product with IPA and apply a bake-out or simply apply a bake-out to obtain acceptable outgassing results.

Silicone and fluorosilicone rubbers generally have inferior mechanical properties. They have good solvent resistance and they have a usable temperature range of -55°C to $+225^{\circ}\text{C}$, and -75°C to $+175^{\circ}\text{C}$, respectively. They often, but not always, require a bake out (minimum of 24 hours at 175°C) to reduce the vacuum outgassing to an acceptable level. When required, a vacuum bake-out is the recommended procedure.

A major difference in the three materials is their brittle point, i.e., the lowest temperature at which the elastomer exhibits rubber-like properties. The brittle point is determined by ASTM D1329 "Temperature Retraction Test" that measures an elastomer's ability to return to a pre-existing condition. As such, it is closer to measuring low temperature compression set and is more directly applicable to O-ring sealing characteristics than glass transition temperature may be.

Changes induced by low temperature exposure are primarily physical and usually reversible as the temperature is increased. If the application is such that an O-ring failure will cause the instrument to malfunction and if the instrument will be exposed to low temperature conditions at any time, the usable low temperature limit must be an important material consideration. Do not, however, overlook other usage parameters such as fluid type, pressure, and configuration that can affect the performance of O-rings regardless of temperature.

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